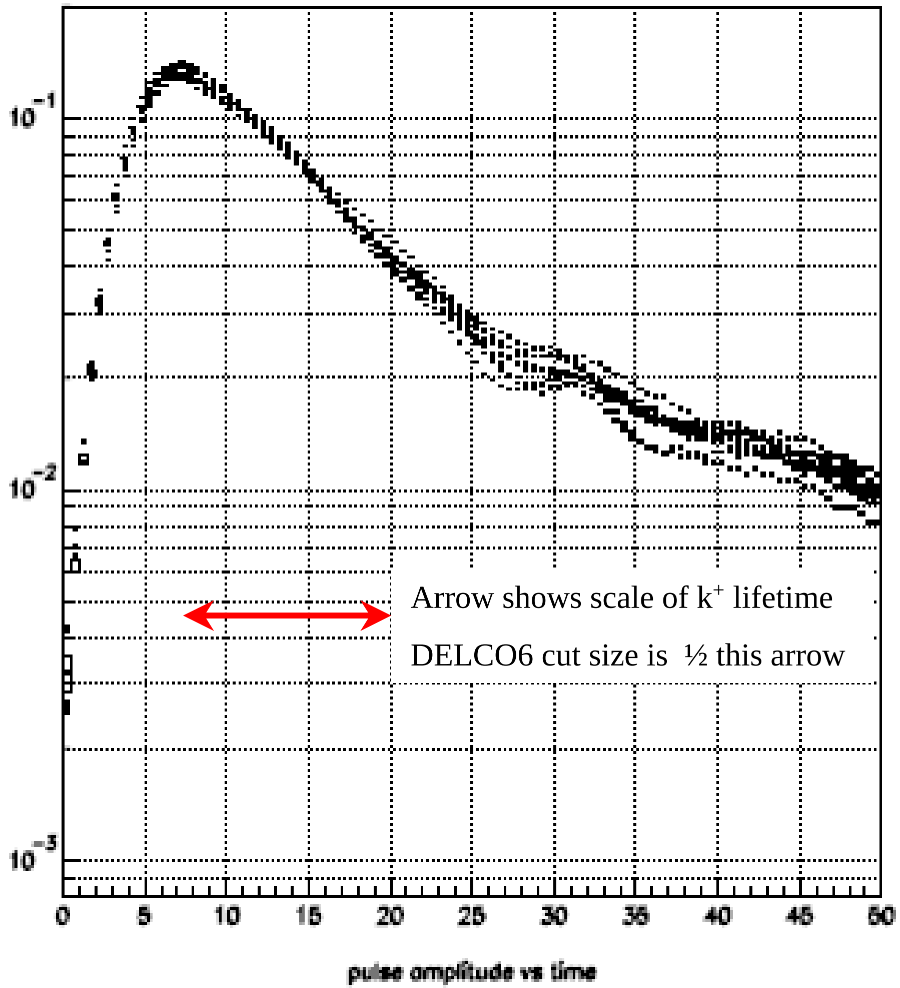
Target CCD cuts in pnn2 ‘CCDPUL’

- CCDPUL can reject some events in which the k decays to a pi and the pi undergoes scattering within a ‘kaon’ fiber
- 2 mechanisms
  - pi travels for some distance in kaon fiber, dropping ~2 MeV/cm through dE/dX
  - Inelastic collision of pion creates secondary particles, some of which may leave a trace of their presence
- Also can reject some background events with extra energy deposited in ‘kaon’ fiber (e. g. photon conversion energy buried in kaon fibers , Ke4 decays, 2-beam bkgds,…).

- Cuts based upon the CCD pulse fits were used in the 1996, and with some changes to improve efficiency, in the 1997 pnn2 analysis. (See Appendix A in Bipul Bhuyan's thesis, or E787 TN391).
- This cut is both inefficient and has poor rejection of backgrounds – at least compared to the major tools used, like PV and RS TD analysis. This is mostly due to:
  - weak physics signature
    - most pnn2 decay pions deposit energy within kaon fibers =>
      - a delicate tuning bar separates some of the background from some of the signal
  - difficulty in finding a real 2^{nd} pulse of rather low energy within several ns of a high energy kaon
    - large dynamic range of ek_tg
    - Pulse shape 90% of amplitude within ~40 ns (see next slide)
    - lifetime of K^+ 12.4 ns
- From TN385 (1996 analysis) "With our standard cut we obtain a rejection of 13.0 (481/37) after all other cuts including DELCO at 6 ns with an acceptance of 0.38".

Average pulse shapes for 10 fibers, target row J



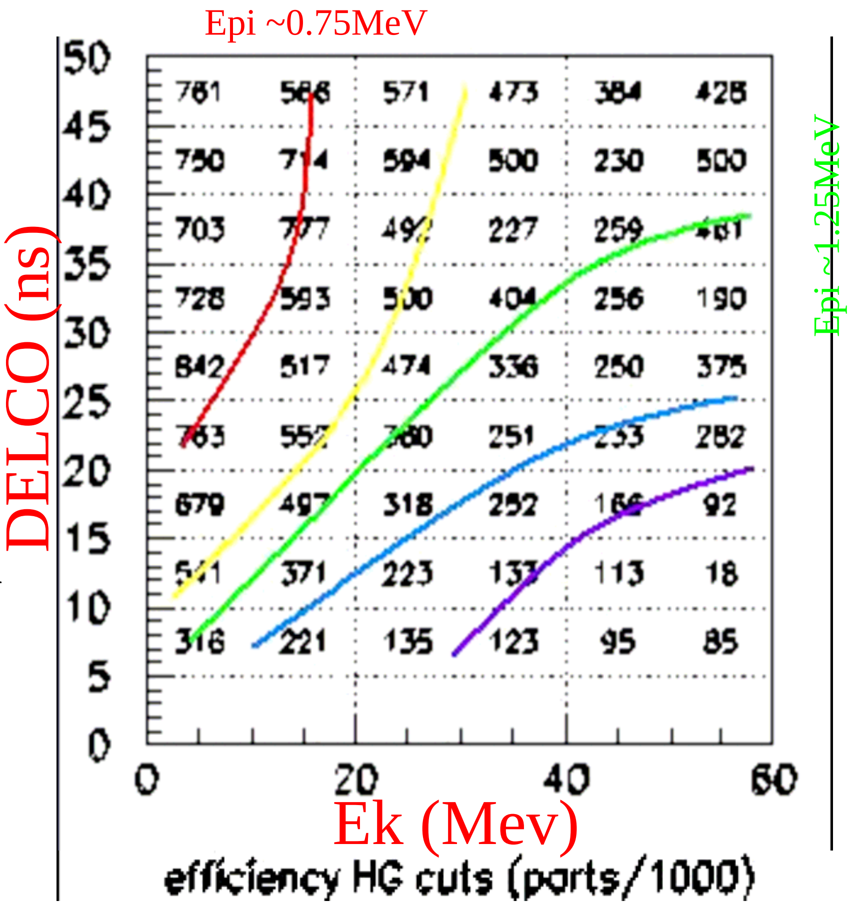
- In E949, CCD hardware as well as typical target gains were similar to that used during E787.
- Analysis changes:
  - Target ‘pulsate’ turned off
  - In fitting routines, error in each of the 2ns bins was parameterized
    - High gain (one CCD channel per fiber):
      - Error in bin i: $0.74+0.69*\mathrm{sqrt}(\mathrm{data}_i)$
    - Low gain (81 channels for 413 fibers):
      - Error in bin i: $1.21+0.35*\mathrm{sqrt}(\mathrm{data}_i)$

    (In E787, errors in each bin were scaled from average pulse and average uncertainty in each bin.)

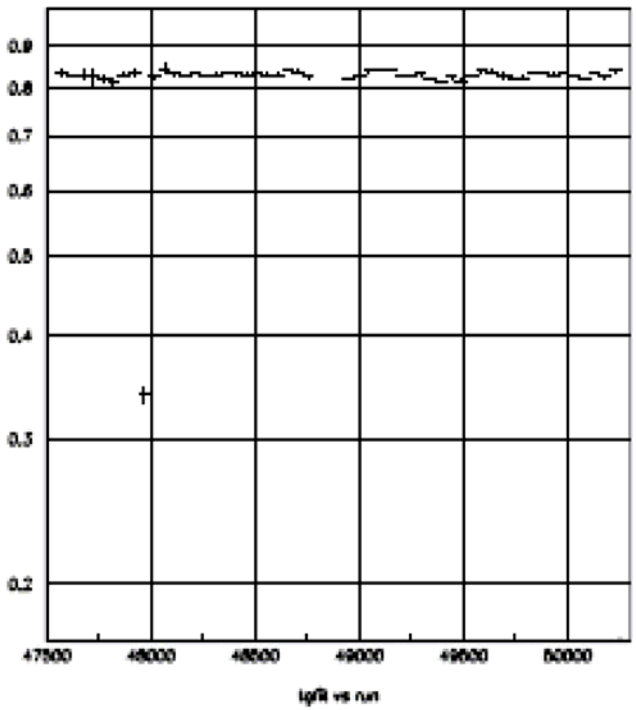
  - Allowed pulse fitting in time range -10 ns to 50 ns (was –3 to +3 ?)
  - Number of fit fibers increased.

- Where are we with CCDPUL_2002?
  - ~same ntuple quantities stored as were used in previous analyses
  - First check by Ilektra many months ago, with Bipul's set of CCDPUL cuts, and unclear sample purity showed a rejection of ~3 or 4. "Better than a prescale, but….".
  - Systematic study (E949 TN #K045) showed that probability of a successful two pulse fit in each fiber is a function of (t2-t1,E1,E2), as expected, and
    - Determined absolute efficiencies for successful reconstruction, using a suggested set of cuts.
    - Determined 'false fit' probabilities

- From TN K045, plot of ~threshold for detecting pions of various energies, as a function of ek_tg and DELCO (high gain CCDs).
- Lots of other information provided (TN is on required reading list for all students!)



Probability that all k fibers (E>3) had successful single pulse hit as a function of run

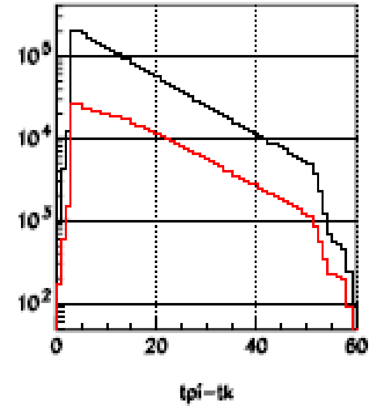


____ all events

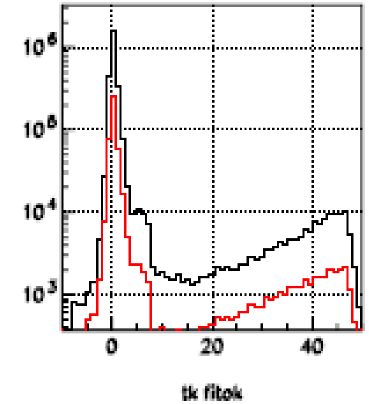
____ at least one fiber had bad single pulse hit

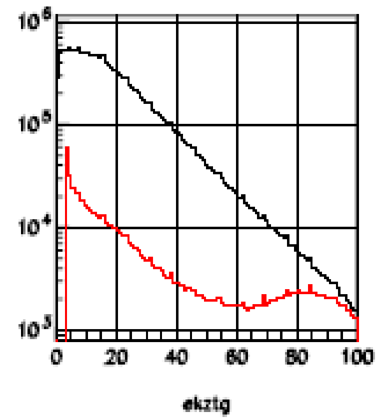
As a function of:

DELCO



kaon time





Kaon fiber energy

- What's next? A possible list to think about….
  - Can pulse fitting be improved?
    - Can we gain in acceptance/rejection by changing global errors to individual parameterization of uncertainty?
    - 'block-out' accidental activity not near tk, tpi
    - Why is performance so poor at ek_tg>60
  - Can existing ntuple quantities be used with more discrimination?
    - Neural net F(t2-t1,e1,e2) or table? (E787 used these in rudimentary form)
    - Neural net F(t2-t1,e1,e2,d_from_decay)
    - Is there a better way to combine low- and high-gain CCD information?
  - Each fiber fit is independent of others and rejection is done on a per fiber cut, but backgrounds (and signal) may correlate several fibers –is this the best way to use information?
    - e. g. Pion heading nearly up- or down- stream may deposit energy in a few kaon fibers before interacting, changing directions, and getting into accepted region.
  - Was change in handling of pulse errors an improvement?
  - ….